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# China's Energy Consumption and Opportunities for U.S.-China Cooperation to Address the Effects of China's Energy Use

## Overview

One of the greatest challenges of the 21st Century will be for countries to act in concert to address global climate change and energy security meaningfully. These are linked problems that cannot be solved in isolation from one another.[1] The U.S. and China are key to any solution as they together consume one-third of global oil supply and emit four-tenths of total greenhouse gas emissions. (See Figure 1.)

China's surging economic growth, emissions, and global influence present both challenges and opportunities to U.S. leadership. Engaging China in a serious, high-level dialogue on issues of shared concern, like energy and climate, can serve U.S. interests within a larger international context. (See Table 1.) Allowing the relationship to be dominated by narrower interests and zero-sum thinking can lead to lose-lose outcomes.

This document provides an update on current energy trends in China, and describes how the U.S. and other international bodies can help address some of the energy and environmental dislocations that have accompanied China's ascent. To be sure, the U.S. can do more to help build Chinese technical, policy and institutional capacity to promote cleaner, more efficient use of energy. More important, however, is for the U.S. to lead by example. Demonstrating that the U.S. can simultaneously address energy security and climate change within a thriving economic context is the most powerful tool we can use to catalyze change in China. Given greater U.S. wealth, cumulative emissions, and reliance on global energy markets, this leadership is a prerequisite. Without it, no amount of technical assistance or political dialogue on cleaner energy will get the traction and leverage it needs in China. A failure to lead may also jeopardize U.S. economic interests in energy and climate technology development.

## A Changing Energy and Climate Landscape

Chinese energy demand has nearly *doubled* since 2000.[2] The repercussions of this surge have reverberated across China and the globe. Inside China, energy shortages, high resource dependence, and environmental pollution have caused a wholesale re-evaluation of the Chinese industrial-driven economic development model. Internationally, concerns over climate change, energy security, and geopolitical conflict have accompanied the rise in demand. The apparent inability of the central government to predict and influence key

[1] See http://www.wri.org/usenergyoptions for a discussion of the linkages and trade-offs in these challenges.
[2] BP Statistical Review of World Energy.

sectors of the economy—electric power expansion, for example—has raised further international concern over the viability of engaging China.

Coal demand in China, supplied almost exclusively by domestic sources, now exceeds 2.4 billion tons per year, nearly twice the level of the U.S. Petroleum consumption, on the other hand, was only one-third of that in the U.S. in 2006. Chinese policymakers, of course, consider per capita consumption as the basis for any international comparison. These figures are far less, but also allude to the potential for continued future growth. The average Chinese consumed one-half, one-twelfth, and one-seventh as much coal, oil and electricity, respectively, as the average American in 2006.

China will, no doubt, soon surpass the U.S. as the leading emitter of greenhouse gas emissions.[3] In the last three years alone, China has constructed about 200 gigawatts[4] of new coal-fired power plants: these plants, and others under construction, will lock in emissions for 40 years or more, and account for a significant share of the remaining global carbon budget needed to stabilize atmospheric concentrations of greenhouse gases at a level scientists believe will prevent the worst impacts of climate change.

Across two administrations, the U.S. has based justification for climate inaction largely on the need for developing countries like China to constrain emissions. While developing and industrialized nations often talk past one another in negotiating climate mitigation responsibilities, a reminder about cumulative emissions is important. After release, carbon dioxide remains in the atmosphere for a century or more. As shown in Figure 2, China will have emitted less than half as much carbon dioxide as the U.S. when measured over the period 1920 and forecasted through 2020. These values are represented by the areas under the respective cures in Figure 2.

After China becomes the undisputed leader in greenhouse gas emissions, and the other major emitters have taken on targets, will it be possible for China to continue without a binding emissions target for long? Trade and diplomatic pressure makes that seem unlikely, no matter how firmly the Chinese currently state otherwise. There is also growing recognition among senior decision-makers that climate change will have enormous impacts on China's water supply, crop production, and exposure to intensified storms, and thus increasing support for taking self-protecting action.

**The Changing Energy-Economic Relationship in China**

Chinese energy demand has surged since the arrival of the new millennium when a new round of energy-intensive investment began. Reported Chinese data indicate that the energy elasticity of demand (the growth rate of energy consumption divided by that of GDP) shifted from an average of approximately 0.5 during the 1980s and 1990s, to about 1.3 over the past 4 years. In other words, energy demand grew by 1.3 percent for every percent growth in GDP, instead of the historical half percent. (See Figure 3.)

[3] "China Issues Plan on Global Warming, Rejecting Mandatory Caps on Greenhouse Gases," NY Times, 4 June 2007

[4] A large power plant is typically 1 gigawatt in size.

Chinese economic and energy statistics are uncertain for both technical and political reasons.[5] Local officials may report data to the central government based on what they think supervising officials want to see, rather than what is really happening. While compilers of national statistics often massage out the worst distortions, important problems remain. For example, coal use from 1996-1999 is now acknowledged as significantly underestimated by analysts both inside and outside of China due to untracked output from small coal mines during this time. One of the contributing factors behind China's current energy crunch is indeed these poorly tracked energy statistics: good energy policy and energy planning require accurate data. Acknowledging these data issues also explains some of the recent surge in energy intensity.

Changes in China's energy-economic relationship are important to understand. Whether the new relationship is temporary or indicates a deeper structural change in the economy will have a profound impact on future global energy markets, energy security, and environmental quality. A satisfactory understanding of what is happening in Chinese energy markets may never be uncovered, but more research into the new energy-economic relationship would benefit the international community and China. U.S. support in this area would benefit our trade, environmental, and security interests, as well as allowing an earlier adoption of functioning carbon markets with China.

**Energy Policymaking**

China currently does not have a ministry of energy to coordinate the development and implementation of energy policy. Creation of such a ministry is widely called for to overcome hierarchical bureaucracy, "stove-piping of information," and weak coordination between energy subsectors. By itself, creating a ministry of energy would not automatically solve the root problems that result in poor energy implementation. Deeper changes in institutional culture are needed. But establishing a centralized ministry is one potential action to initiate these deeper changes. An energy ministry could help prioritize decision-making, evaluate trade-offs more efficiently, and speak with clearer authority. International stakeholders should thus support the creation of such a ministry, and encourage deeper reform in Chinese energy institutions.

Energy pricing is another important policy issue in China. Below-cost pricing of refined oil products and electricity, in particular, have been noted for creating distortions in supply and demand. But most energy prices in China are now very close to global levels. Gasoline is over US$2 per gallon, coal in the Eastern demand centers is often over US$60/ton, and electricity, while highly variable, is often US$0.06 or more per kilowatt-hour. Chinese policymakers, as do their counterparts in the U.S., face enormous public opposition from high energy prices, particularly rapid increases. Realistic opportunities do exist to alter the relative pricing of cleaner energy options, though. Natural gas-fired power generation, for example, does not compete on a level playing field with dirtier coal and should enjoy greater pricing benefits.

[5] See, for example, *Chinese Economic Performance in the Long-Run*, A. Maddison, OECD, Paris, 1998; or "What Goes Up: Recent Trends in China's Energy Consumption," J. Sinton and D. Fridley, LBNL, Berkeley, 2000.

## Clean Energy Options

China is pursuing many options to address energy needs within its larger economic development framework. Priority options consider cost, labor, finance, energy security and, increasingly, environmental issues. The following list of international collaboration options was taken from a forthcoming study by the World Resources Institute.[6] Additional information is found in another forthcoming study on climate change.[7] A more comprehensive list of options, together with their selected drivers and barriers, is presented in the matrix in Table 2.

### *Energy Efficiency*

Efforts to reduce the wasteful use of energy are the most powerful and affordable measures China can take to meet economic development goals and reduce greenhouse gas emissions. Benefits of improved energy efficiency accumulate over time and can have a significant impact on energy security, local and regional environmental quality, and levels of investment for new energy supply infrastructure.

China is pursuing a massive initiative to lower energy intensity by 20 percent by 2010. This is an enormously challenging target, and the central government has allocated relatively little new resources to help bring about the change. Still, the effort has become something of a political campaign and its outcome will help answer whether the central government can exert effective policy leadership, especially in the energy sector.

In addition, several additional energy efficiency programs were announced by the National Development and Reform Commission at the end of 2006, including a program to improve the energy efficiency of China's top 1,000 largest enterprises, and programs to shut down inefficient power and industrial plants.

Despite the massive attention to energy efficiency today in China, there is still room for additional collaboration with international partners, and several areas where bi- and multi-lateral collaboration to improve end-use and supply-side efficiency in China can be strengthened. There is a need for further capacity building focusing on the business, financial, and regulatory skills needed to promote energy efficiency projects and standards, and to reform policies and regulations that impede market-driven efficiency projects. Special efforts should be focused on improving energy and economic data gathering, with the goal of improving the transparency of the relationship between energy, economic activity and greenhouse gas emissions in China.

### *Energy Security*

China's booming economy has required a huge expansion in imported raw material inputs, especially oil, since 2001. Chinese national oil companies (NOCs) have embarked on a strategy to purchase oil and gas assets around the globe as a way to increase energy security. It remains unclear if this is a long-term Chinese policy or an experimental phase,

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[6] "Clean Energy Options in China: Opportunities and Barriers for Philanthropic and Market-based Investment," World Resources Institute (forthcoming), Washington, DC.

[7] "Understanding the Climate Challenge in China," J. Lewis, M. Cummings, and J. Logan, in *Climate Change Science and Policy* (forthcoming).

but there is clearly the need for China and other major energy consumers to discuss more seriously their shared global energy concerns.

To address the current sense of liquid fuels insecurity, China is developing coal liquefaction technology. This option offers the impression of boosting self-sufficiency, but China will not solve its liquid fuel insecurity by insulating itself from global markets. One need look no further than the purely domestic electricity crisis of 2004-2005 to realize this: poor information and planning led to severe electricity shortages with significant impacts on global energy markets and environmental pollution. More important to international stakeholders, however, is the climate impact that such a fuel substitution program would create. Coal liquefaction results in approximately twice as much $CO_2$ entering the atmosphere as standard crude use and is heavily dependent on water resources that are scarce in China's coal-bearing regions. While carbon capture and storage could displace some of these emissions, it would add substantially to the cost and complexity.

There is a clear need to better integrate China into the global energy system. Greater participation in the IEA, G-8 and other global bodies involved in shared global energy discussions would give China greater ownership and responsibility in the global energy system.[8] The U.S. and other key nations should accelerate high-level dialogues with China to ensure that each others' concerns are understood and discussions of opportunities and options occur regularly. Stockpiling oil to be released in global coordination is part of a shared "global good" that China could be encouraged to participate in. But greater trust first needs to emerge.

To build good will, the U.S. could take a meaningful measure to improve the efficient use of oil in its transport sector. Committing to raise average fuel efficiency standards by 25 percent over a 10-year period, for example, would send a powerful signal to global oil markets and perhaps build confidence in other areas of Sino-U.S. cooperation. This policy measure may happen on its own, but the U.S. should reach out to China to make it a joint venture. As part of a more regular dialogue on issues of shared concern, China and international partners could also hold deeper technical collaboration on vehicle technologies, alternative fuels, and associated policies.

***Advanced Coal Technologies and Carbon Capture and Storage***

China's fleet of coal-fired power plants is expanding dramatically and presents the most visible challenge (and opportunity) for global emissions mitigation. The total installed coal power plant capacity at the end of 2006 was about 470 gigawatts, one-third larger than that in the U.S.

Provided that it can overcome technical, cost, regulatory, and social barriers, carbon dioxide capture and geological sequestration (CCS) may become an important option for reducing greenhouse gas emissions from fossil-burning plants throughout the world, but especially in coal-intensive countries such as China. While China is unlikely to invest in

[8] Lieberthal, Kenneth and Mikkal Herberg, "China's Search for Energy Security and Implications for U.S. Policy," *NBR Analysis*, Volume 17, No. 1, April 2006.

CCS systems for coal plants in the next decade or two due to the added costs, it is eager to collaborate on integrated gasification combined-cycle (IGCC) power plant research and deployment. These plants have the potential to produce significantly less pollution than pulverized coal alternatives, and can offer an efficient base from which to produce a number of petrochemical feedstocks using domestic coal. Carbon dioxide emissions from these plants can also be captured for relatively low incremental cost if designed to do so in advance, but retrofitting them later to capture emissions is not a simple or inexpensive option.[9] China is also keenly interested in enhanced oil and methane recovery technologies that could sequester carbon dioxide in the process. The U.S. and Canada have extensive experience in this field. Collaborative research on underground coal gasification is also of mutual interest. Building collaborative interest and capacity on these topics could lay important groundwork for more rapid future deployment of CCS in China.

There are several international partnerships aimed at bringing advanced coal power technologies to China. A UK-led initiative is part of the China-EU partnership on climate change with a goal to move up the future date when new Chinese coal plants can be built with CCS. The International Energy Agency in Paris has also started a related set of collaborative studies on clean coal in China. Huaneng Power, China's largest coal-based power generation company, is one of ten international energy companies participating in the U.S. FutureGen "clean coal" project, attempting to become the world's first integrated sequestration and hydrogen production power plant. Huaneng is also leading its own version of FutureGen in China called "GreenGen".

China is collaborating with international partners on coal and CCS technologies through the Asia Pacific Partnership on Clean Development and Climate (APP). While the Partnership brings together an important grouping of nations, limited funding and the voluntary nature of the efforts have so far limited progress.

China is also a member of the Carbon Sequestration Leadership Forum (CSLF), an international initiative of 22 countries to promote the development of improved, cost-effective technologies for the capture and geological sequestration of carbon dioxide. The CSLF is currently partnering with the International Energy Agency to deliver recommendations to the G-8 process in 2008 on how carbon dioxide capture and storage can be enhanced in the near term.

The single most important measure the U.S. could take to promote clean coal and CCS use in China would be to set a strong example at home. Demonstrating that CCS is a safe and viable business model is essential. The U.S. needs to do more than talk or it risks alienating future collaborative options.

***Deploying Renewable Energy***

China is actively developing industries around renewable energy technology and has set aggressive targets for their deployment. China's national renewable energy law offers

[9] *The Future of Coal*: *An Interdisciplinary MIT Study*, Massachusetts Institute of Technology, Cambridge, 2007.

incentives for their use. Targets that have been announced in conjunction with the renewable energy law and subsequent government announcements. The overarching goal is to have 20 percent of electricity capacity from renewables by 2020, which includes 30 GW of wind power, 20 GW of biomass power, and 300 GW of hydropower capacity. Policies to promote many renewable energy technologies in China also aim to encourage local technology industry development; China is already producing commercial large wind turbines that rival European and North American options,[10] and 35 million homes in China get their hot water from solar collectors—more than the rest of the world combined.[11] China is also home to a burgeoning solar photovoltaic industry.

Despite this progress, renewables will continue to make up a relatively small fraction of the energy mix in China over the next few decades. International collaboration with China to further commercialize wind, solar, biomass and other renewable energy technologies could pay enormous dividends. Chinese manufacturers can drive cost reductions that make possible more wide-scale penetration of these clean options around the world. Many existing international fora, such as the UNFCCC and the WTO, are being underutilized as opportunities to discuss key issues surrounding renewable energy technology transfer, including the role governments can play in facilitating the sharing and the protection of intellectual property rights.[12]

## Conclusions

China must be part of any global response to climate change and energy insecurity. The U.S. will almost certainly need to act first, however, given its greater wealth, resource endowments, and historical emissions. While there is growing federal support to put a binding cap on greenhouse gas emissions, China presents both a real and perceived threats to U.S. "unilateral" action. The potential impacts on trade that would result from an asymmetrical carbon regime, for example, must be more thoroughly considered, although studies suggest that only a few U.S. sectors would be affected by carbon-intensive Chinese imports.[13] Policies could be developed to address these impacts.

The U.S. could intensify cooperation with China on a variety of clean energy options. Four have been discussed here. But successful collaboration will require confidence building measures that overcome mistrust and a sense of insincerity. By demonstrating domestic action to improve global energy security and mitigate greenhouse gas emissions, the U.S. could initiate that new-found trust.

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[10] Lewis, Joanna I., 2005. *From Technology Transfer to Local Manufacturing: China's Emergence in the Global Wind Power Industry*, Ph. D. Thesis, Energy and Resources Group, University of California – Berkeley, August; Wu Yundong. 2004. "Manufacturing Technology of Wind Turbines (Grid Connected) in China." Proceedings of the World Wind Energy Congress, Beijing, China, October 31-November 4.

[11] Reuters, 2005. "China seen world leader in clean energy." September 29.

[12] Ibid.

[13] See International Sectoral Cooperation on Climate Change: Issues and Options, WRI, forthcoming; and China Balance Sheet project (http://www.chinabalancesheet.org/).

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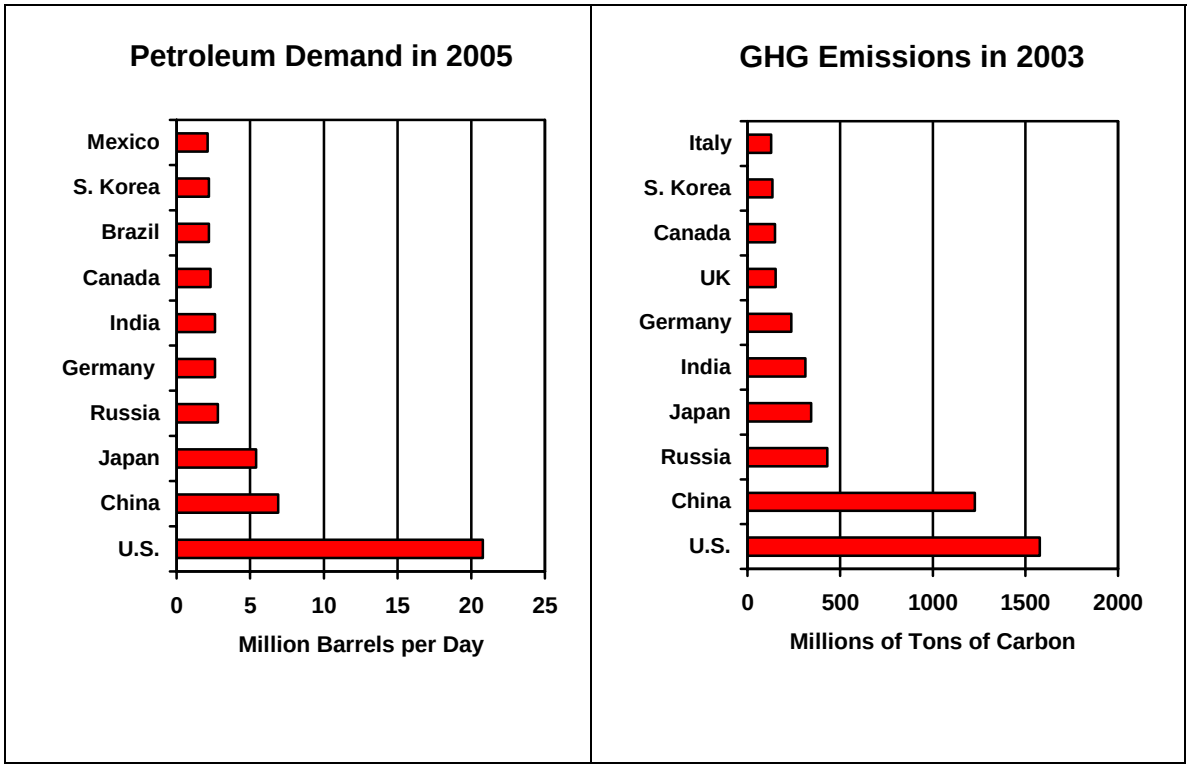
**Table 1 – The U.S. Stake in Global Energy Markets**

| | |
|---|---|
| **Economic**<br>• Development<br>• Energy technology export | **International Security**<br>• Secure supplies of foreign oil<br>• Nuclear non-proliferation<br>• Political stability in developing countries |
| **Environmental**<br>• Local air quality<br>• Regional acid rain<br>• Global Warming | **U.S. Values**<br>• Human rights<br>• Civil society<br>• Equity, self-determination, and stewardship |
| **U.S. Leadership**<br>• Energy science<br>• Supply and demand-side technology | |

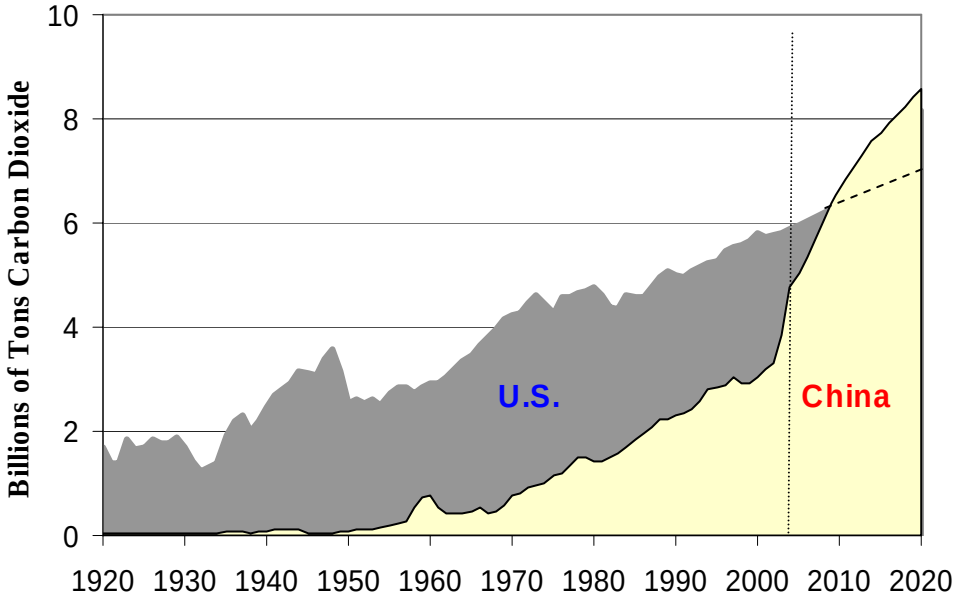
Source: U.S. President's Committee of Advisors on Science and Technology, *Powerful Partnerships: The Federal Role in International Cooperation on Energy Innovation* (Washington, D.C.: The White House Office of Science and Technology Policy, June 1999).

**Figure 1 – Leading Oil Consumers and Greenhouse Gas Emitters**




Source: WRI CAIT 2007.

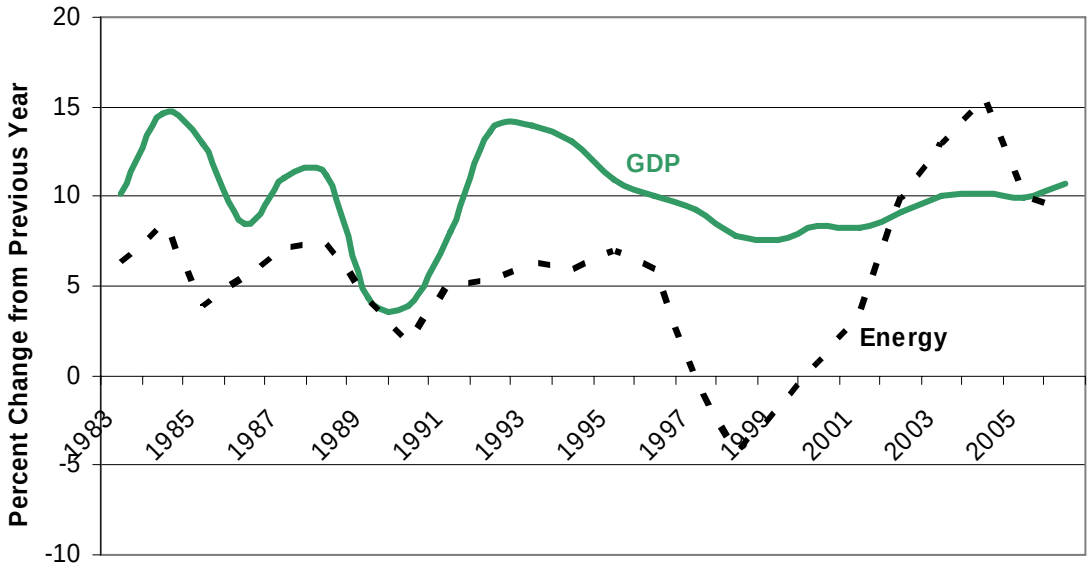
**Figure 2 – Greenhouse Gas Emissions in the U.S. and China**




**Cumulative totals from 1920 forecasted through 2020:**
**US – 404 billion tons; China – 184 billion tons.**

Source: U.S. Energy Information Administration, International Energy Outlook.

**Figure 3 – China's Energy Consumption and GDP, Annual Change**




Source: China Statistical Yearbook, various years.

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**Table 2: China Clean Energy Prioritization Matrix**

| Option/Issues | Economic Cost | Environmental Impact | Climate Impact | Technology Readiness | Institutional Issues | External Competition | Domestic Traction | Other Issues |
|---|---|---|---|---|---|---|---|---|
| Natural Gas | -1 | +2 | +1 | +1 | -1 | Some | Some | Import dependency |
| Nuclear | -1 | +1 | +2 | -1 | -2 | Narrow | Narrow | Waste, Safety, Weapons |
| Wind/Small Hydro/Solar | -1 | +1 | +1 | +1 | 0 to -1 | High | Moderate to strong | Scale |
| Agricultural waste | -1 to +1 | +1 | +2 | -1 to +1 | -1 | Some | Location specific | Soil quality, Poor perception |
| Efficiency | +1 | +1 | +1 | +2 | -1 | Strong | Strong | Current Focus |
| Hydrogen | -2 | Depends | Depends | -2 | -2 | Some | Some | Uncertainty |
| Clean Coal | -1 | +1 | +1 | -1 | -1 | Some | Moderate | Water, Reliability |
| Carbon Capture and Storage | -2 | +1 | +2 | -1 | -1 | Little | Some | Storage capacity |
| Transport Measures | Depends | +1 | +1 | +1 | -2 | Location specific | Location specific | Energy security, Right to mobility |
| Biofuels | -1 | -1 | +1 | 0* | -1 | Some | Moderate | Food security, Energy security |
| Large Hydro | -1 | Depends | Depends | +2 | -1 | Little | Little | Local populations |

NB: Scores ranging from (-2) to (+2) are qualitative judgments based on WRI analysis and compared against “business as usual” options.